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# *Indian Standard*
# SPECIFICATION FOR NICKEL RESISTANCE THERMOMETER ELEMENTS

( First Reprint MAY 1986 )

UDC 536.531:621.317.39:621.316.84

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NEW DELHI 110002

Gr 3

*April* 1971

# *Indian Standard*
# SPECIFICATION FOR NICKEL RESISTANCE THERMOMETER ELEMENTS

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# *Indian Standard*

# SPECIFICATION FOR NICKEL RESISTANCE THERMOMETER ELEMENTS

## 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 12 October 1970, after the draft finalized by the Electrical Instruments Sectional Committee had been approved by the Electrotechnical Division Council.

**0.2** The measurement of temperature by means of the change in the resistance of a temperature-sensitive element is one of the most commonly used and convenient method of temperature measurement. Platinum and nickel are usually employed for this purpose because of their high temperature coefficient, reproducibility and stability. This standard covers only the industrial nickel resistance thermometer elements. Platinum resistance thermometer elements are covered by IS : 2848-1965*.

**0.3** Nickel-resistance elements are satisfactory for use between the temperature of –60 to +150°C. By suitable protection, they may also be used above +150°C.

**0.4** Guidance regarding the methods to be used for the temperature measurement by means of a change in resistance, limitation of this method and the precautions ( *see also* Appendix A ) which should be taken, are given in IS : 2806-1964†.

**0.5** In the preparation of this standard, assistance has been derived from DIN 43760-1968 Ohmic resistance of nickel and platinum resistance thermometers issued by the Deutscher Normenausschuss.

**0.6** This standard is one of a series of Indian Standards on electrical instruments.

**0.7** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960‡. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Specification for platinum resistance thermometer elements.

†Methods of temperature measurement by electrical resistance thermometers.

‡Rules for rounding off numerical values ( *revised* ).

## 1. SCOPE

**1.1** This standard specifies requirements for temperature detecting industrial nickel resistance elements adjusted to give a specific change of electrical resistance for a stated temperature change, for use on ac up to 1 000 Hz and dc.

## 2. TERMINOLOGY

**2.1** For the purpose of this standard, the definitions given in **2** of IS : 2848-1965* shall apply.

## 3. TYPES

**3.1** The nickel resistance thermometer elements shall be one of the following two types:

a) *Type 1* — With elements wound on a mica strip former, and

b) *Type 2* — With elements wound on a round glass rod.

## 4. CONSTRUCTION

**4.1 General** — The conductor should be wound on to a bobbin or a former. The technique of supports shall be such that it avoids strain in the element both during fabrication and use.

**4.2 Thermo-emf** — The element shall be so constructed that no thermoelectric voltage is generated within them.

## 5. OVERALL DIMENSIONS†

**5.1 Type 1** — The overall dimensions of elements with single as well as double winding shall be in accordance with Fig. 1.

### 5.2 Type 2

**5.2.1** *Elements with Single Winding* — The overall dimensions shall be in accordance with Fig. 2A.

**5.2.2** *Elements with Double Winding* — The overall dimensions shall be in accordance with Fig. 2B.

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*Specification for platinum resistance thermometer elements.

†The dimensions for outer protective sheaths are under consideration and will be included later.

## 6. RESISTANCE OF LEADS

**6.1** The resistance of leads shall not exceed 0·1 percent of the value of the resistance of the element, both measured at 0°C.

## 7. TEMPERATURE RANGE

**7.1** All nickel resistance thermometer elements shall be suitable for measuring temperatures from −60 to +150°C for continuous use and up to +180°C for short duration or intermittent use.

## 8. ELECTRICAL SUPPLY

**8.1** The elements shall be suitable for use on dc electrical supplies and ac systems up to 1 000 Hz.

**8.1.1** To enable an accurate ac measuring system to be designed, a maximum value of the relevant electrical characteristics ( for example, element capacitance, capacitance to earth, inductance, etc ) shall be stated by the manufacturers at:

a) a temperature not exceeding ambient temperature, and

b) the maximum intended temperature of use.

## 9. RELATIONSHIP BETWEEN RESISTANCE RATIO AND TEMPERATURE

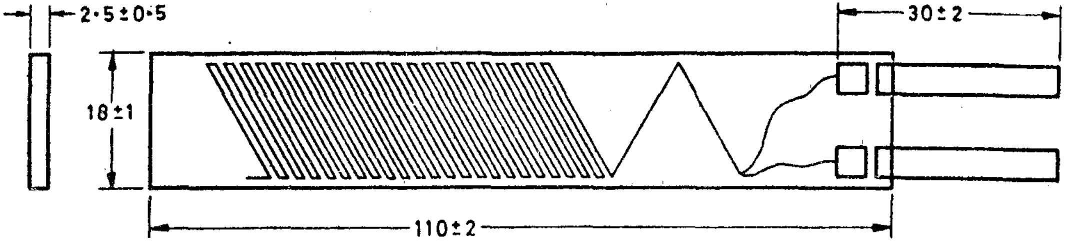
**9.1** For the purpose of this standard, the relationship between the nominal resistance and temperature given in Appendix B is based on $R_{100}/R_0 = 1{\cdot}617$.

## 10. FUNDAMENTAL INTERVAL AND RESISTANCE VALUES

### 10.1 Fundamental Interval

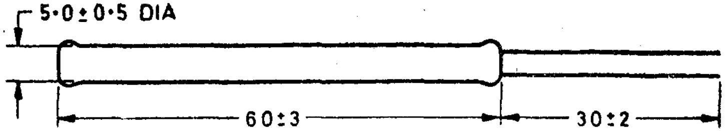
**10.1.1** *Temperature Measurements Not Exceeding +150°C* — The element shall have a fundamental interval of 61·70 ohm.

**10.1.2** *Temperature Measurements Exceeding +150°C* — The elements shall have a fundamental interval of 61·70, 10·000 or 1·000 0 ohm whichever is appropriate.

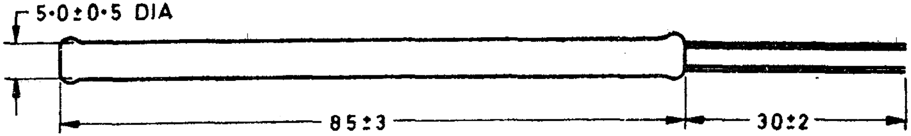


All dimensions in millimetres.

FIG. 1 NICKEL RESISTANCE THERMOMETER ELEMENT (TYPE 1)



2A Element with Single Winding



2B Element with Double Winding

All dimensions in millimetres.

FIG. 2 NICKEL RESISTANCE THERMOMETER ELEMENT (TYPE 2)

## 10.2 Resistance Values

**10.2.1** *Element with Fundamental Interval of 61·70 Ohm* — The resistance values for the basic element shall be as given in Table 1.

TABLE 1 RESISTANCE OF 61·70 OHM FUNDAMENTAL INTERVAL ELEMENTS

| TEMPERATURE (1) °C | RESISTANCE (2) ohm | TEMPERATURE (1) °C | RESISTANCE (2) ohm | TEMPERATURE (1) °C | RESISTANCE (2) ohm |
|---|---|---|---|---|---|
| —60 | 69·50 | 30 | 117·1 | 120 | 175·9 |
| —50 | 74·20 | 40 | 123·0 | 130 | 183·3 |
| —40 | 79·10 | 50 | 129·1 | 140 | 190·9 |
| —30 | 84·10 | 60 | 135·3 | 150 | 198·7 |
| —20 | 89·30 | 70 | 141·7 | 160 | 206·7 |
| —10 | 94·60 | 80 | 148·2 | 170 | 214·9 |
| 0 | 100·0 | 90 | 154·9 | 180 | 223·1 |
| 10 | 105·6 | 100 | 161·7 | | |
| 20 | 111·3 | 110 | 168·7 | | |

**10.2.1.1** *Tolerances* — The tolerances shall be in accordance with Table 2.

TABLE 2 TOLERANCES FOR 61·70 OHM FUNDAMENTAL INTERVAL ELEMENTS

| TEMPERATURE* | TOLERANCE† ON RESISTANCE OF ELEMENT | |
|---|---|---|
| | Resistance | Approximately Equivalent Temperature |
| (1) | (2) | (3) |
| °C | ohm | °C |
| —60 | ± 1·0 | ± 2·1 |
| 0 | ± 0·1 | ± 0·2 |
| 100 | ± 0·8 | ± 1·1 |
| 150 | ± 1·1 | ± 1·4 |
| 180 | ± 1·3 | ± 1·5 |

*If elements are tested at temperatures other than those tabulated, then the tolerance applicable shall be determined by interpolation.

†The tolerances are not sharply defined; that is, one value goes over to next gradually.

**10.2.2** *Elements with Fundamental Interval Other than 61·70 Ohm* — When the maximum temperature to be measured exceeds 150°C, elements of

10·000 ohm and 1·000 0 ohm fundamental intervals may be used if the use of 61·70 ohm fundamental interval element is considered inappropriate. The resistance values of 10·000 ohm and 1·000 0 ohm fundamental interval elements shall be as given in Tables 3 and 4 respectively.

**10.2.2.1** *Tolerances* — The tolerances for the values given in Tables 3 and 4 shall be as agreed to between the purchaser and the manufacturer.

### TABLE 3 RESISTANCE OF 10·000 OHM FUNDAMENTAL INTERVAL ELEMENT

( *Clauses* 10.2.2 *and* 10.2.2.1 )

| Temperature (1) °C | Resistance (2) ohm | Temperature (1) °C | Resistance (2) ohm | Temperature (1) °C | Resistance (2) ohm |
|---|---|---|---|---|---|
| —60 | 11·26 | 30 | 18·98 | 120 | 20·51 |
| —50 | 12·03 | 40 | 19·94 | 130 | 29·71 |
| —40 | 12·82 | 50 | 20·92 | 140 | 30·94 |
| —30 | 13·63 | 60 | 21·93 | 150 | 32·20 |
| —20 | 14·47 | 70 | 22·97 | 160 | 33·50 |
| —10 | 15·33 | 80 | 24·02 | 170 | 34·83 |
| 0 | 16·21 | 90 | 25·11 | 180 | 36·16 |
| 10 | 17·12 | 100 | 26·21 | | |
| 20 | 18·04 | 110 | 27·34 | | |

### TABLE 4 RESISTANCE OF 1·000 0 OHM FUNDAMENTAL INTERVAL ELEMENT

( *Clauses* 10.2.2 *and* 10.2.2.1 )

| Temperature (1) °C | Resistance (2) ohm | Temperature (1) °C | Resistance (2) ohm | Temperature (1) °C | Resistance (2) ohm |
|---|---|---|---|---|---|
| —60 | 1·126 | 30 | 1·898 | 120 | 2·851 |
| —50 | 1·203 | 40 | 1·994 | 130 | 2·971 |
| —40 | 1·282 | 50 | 2·092 | 140 | 3·094 |
| —30 | 1·363 | 60 | 2·193 | 150 | 3·220 |
| —20 | 1·447 | 70 | 2·297 | 160 | 3·350 |
| —10 | 1·533 | 80 | 2·402 | 170 | 3·483 |
| 0 | 1·621 | 90 | 2·511 | 180 | 3·616 |
| 10 | 1·712 | 100 | 2·621 | | |
| 20 | 1·804 | 110 | 2·734 | | |

## 11. MARKING

**11.1** In the case of elements with double winding, the leads shall be marked ' 1-1 ' and ' 2-2 ' to identify the two elements.

**11.1.1** The following shall also be suitably marked:

a) Manufacturer's name or trade-mark,
b) Type,
c) Fundamental interval,
d) Material of thermo-element, and
e) Country of manufacture.

**11.2** The nickel resistance thermometer element may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution ( Certification Marks ) Act, and the Rules and Regulations made thereunder. Presence of this mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard, under a well defined system of inspection, testing and quality control during production. This system, which is devised and supervised by ISI and operated by the producer, has the further safeguard that the products as actually marketed are continuously checked by ISI for conformity to the standard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

## 12. TESTS

### 12.1 Classification of Tests

**12.1.1** *Type Tests* — The following shall constitute the type tests:

a) Insulation resistance ( **12.3** ),
b) Resistance accuracy ( **12.4** ),
c) Thermal response time ( **12.5** ),
d) Self heating ( **12.6** ),
e) Immersion error ( **12.7** ),
f) Thermo-electric effect ( **12.8** ),
g) Limiting temperatures ( **12.9** ), and
h) Stability ( **12.10** ).

**12.1.2** *Routine Tests* — The following shall be carried out as routine tests:

a) Insulation resistance ( **12.3** ), and
b) Resistance accuracy ( **12.4** ).

**12.2 General** — For the tests given in **12.3** to **12.10** references have been made to IS : 2848-1965*. In case of inconsistencies, if any, between IS : 2848-1965* and this standard, the provisions of the latter shall apply.

**12.3 Insulation Resistance** — With the element mounted in a close fitting metal sheath having dry external surfaces, the insulation resistance between any terminal and the sheath shall be not less than 10 megohms when measured with a nominal voltage of 500V dc and at the room temperature. Also the insulation resistance between any terminal and the sheath at 50V dc and a temperature of 180°C or the rated maximum whichever is lower, shall be not less than 1 megohm.

NOTE — For routine test, only the test given at room temperature shall be carried out.

**12.4 Resistance Accuracy** — The test shall be carried out in accordance with **9.3** of IS : 2848-1965*.

**12.4.1** The resistance shall be within the limits specified in Table 2.

NOTE — For routine test, this test shall be carried out according to **12.4** except that it will be sufficient if the test is made at not fewer than two suitably spaced points over the declared working range of temperature.

**12.5 Thermal Response Time** — The test shall be carried out in accordance with **9.4** of IS : 2848-1965*.

**12.6 Self-Heating** — The test shall be carried out in accordance with **9.5** of IS : 2848-1965*.

**12.7 Immersion Error** — The test shall be carried out in accordance with **9.6** of IS : 2848-1965*.

**12.8 Thermo-Electric Effect** — The test shall be carried out in accordance with **9.7** of IS : 2848-1965*.

**12.8.1** The resistance of the element shall be determined by the method detailed in **12.4**.

**12.9 Limiting Temperatures** — The test shall be carried out in accordance with **9.8** of IS : 2848-1965*.

**12.9.1** At the end of the test period the element shall comply with the requirements of **12.3** and **12.4**.

**12.10 Stability** — The test shall be carried out in accordance with **9.9** of IS : 2848-1965*.

**12.10.1** When no limiting temperatures are declared the test shall be made at 150°C and at the temperature of liquid nitrogen boiling at atmospheric pressure.

**12.10.2** At the conclusion of the test the element shall comply with the requirements of **12.4**.

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*Specification for platinum resistance thermometer elements.

# APPENDIX A

( *Clause* 0.4 )

## PRECAUTIONS FOR INSTALLATION

### A-1. PRECAUTIONS

**A-1.1** When installing the resistance elements care should be taken to ensure that the whole length of the element is inside the test medium. The resistance element always takes the mean value of the temperatures which operate on its length. Trouble-free working of resistance elements is dependent on maximum care in installation in vibration-free position.

# APPENDIX B

( *Clause* 9.1 )

## RELATIONSHIP BETWEEN RESISTANCE RATIO AND TEMPERATURE

### B-1. RESISTANCE RATIOS

**B-1.1** For resistance thermometer elements consisting of pure nickel together with some device, such as a ballast resistor having negligible change of resistance with temperature to make the ratio of the complete element $\frac{R_{100}}{R_0} = 1{\cdot}617$, the values of the resistance ratios are as given in Table 5.

**TABLE 5 TEMPERATURE/RESISTANCE RATIO RELATIONSHIP**

| Temperature (1) °C | Resistance Ratio, $Rt/R_0$ (2) | Temperature (1) °C | Resistance Ratio, $Rt/R_0$ (2) | Temperature (1) °C | Resistance Ratio, $Rt/R_0$ (2) |
|---|---|---|---|---|---|
| —60 | 0·695 0 | 30 | 1·171 | 120 | 1·759 |
| —50 | 0·742 0 | 40 | 1·230 | 130 | 1·833 |
| —40 | 0·791 0 | 50 | 1·291 | 140 | 1·909 |
| —30 | 0·841 0 | 60 | 1·353 | 150 | 1·987 |
| —20 | 0·893 0 | 70 | 1·417 | 160 | 2·067 |
| —10 | 0·946 0 | 80 | 1·482 | 170 | 2·149 |
| 0 | 1·000 | 90 | 1·549 | 180 | 2·231 |
| 10 | 1·056 | 100 | 1·617 | | |
| 20 | 1·113 | 110 | 1·687 | | |

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